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Flat Field Anomalies In An X-Ray CCD Camera Measured Using A Manson X-Ray Source

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Abstract. The Static X-ray Imager (SXI) is a diagnostic used at the National Ignition Facility (NIF) to measure the position of the X-rays produced by lasers hitting a gold foil target. It determines how accurately NIF can point the laser beams and is critical to proper NIF operation. Imagers are located at the top and the bottom of the NIF target chamber. The CCD chip is an X-ray sensitive silicon sensor, with a large format array (2k x 2k), 24 μm square pixels, and 15 μm thick. A multi-anode Manson X-ray source, operating up to 10kV and 2mA, was used to characterize and calibrate the imagers. The output beam is heavily filtered to narrow the spectral beam width, giving a typical resolution $E/\Delta E \approx 12$. The X-ray beam intensity was measured using an absolute photodiode that has accuracy better than 1% up to the Si K edge and better than 5% at higher energies. The X-ray beam provides full CCD illumination and is flat, within ±1.5% maximum to minimum. The spectral efficiency was measured at 10 energy bands ranging from 930 eV to 8470 eV. The efficiency pattern follows the properties of Si. The maximum quantum efficiency is 0.71. We observed an energy dependent pixel sensitivity variation that showed continuous change over a large portion of the CCD. The maximum sensitivity variation was >8% at 8470 eV. The geometric pattern did not change at lower energies, but the maximum contrast decreased and was less than the measurement uncertainty below 4 keV. We were also able to observe debris on the CCD chip. The debris showed maximum contrast at the lowest energy used, 930 eV, and disappeared by 4 keV. The Manson source is a powerful tool for characterizing the imaging errors of an X-ray CCD imager. These errors are quite different from those found in a visible CCD imager.

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